A study has been made of the monthly mean pressures, the prevailing winds, and their average speed for the two Pacific stations, Midway Island and Honolulu, also for the California coast stations with a view of discovering whether these marginal stations of the North Pacific statistical anticyclone show any evidence of fluctuations which might reasonably be ascribed to changes in the intensity or the geographic position of the latter. The result is a negative one, although it may be mentioned that the coastal stations give evidence of a continental rather than an oceanic control.

Anticyclones, whether of the daily migrating or the statistical sort, have a clearly recognized tendency to move equatorward and thus to successively pass into warmer and warmer regions. The winds in these formations blow outward at the surface and unless there is a corresponding inflow aloft, of which the evidence is either vague or lacking entirely, the anticyclone as such must carry within its organization the seeds of early dissolution.

Following the line of thought in the preceding paragraph, we are led to the conclusion that high pressure in the North Pacific statistical anticyclone in August, let us say, will not endure as such beyond a month or so at the utmost, and can not therefore be a significant factor in the weather of the Pacific coast six months later. This is not said with an air of finality, but rather it is what the writer's study and experience would lead him to expect.

The method of correlation coefficients does not yield significant results, nor could it be expected to do so, because no representative station lies within the central portion of the anticyclone we are considering. The greatest obstacle to reaching an early decision as to the influence of the pressure in late summer upon the weather of western United States six months later is the lack of pressure observations in the northeast Pacific or more specifically in the region included between the parallels of 35° to 50° north and the meridians of 135° to 170° west longtitude. Few ships navigate the central region of high pressure and the probability of an increase in the number of ships' reports is rather remote. What is needed is an exploring vessel to cruise in the region above outlined taking and reporting by radio, meteorogical observations daily for a period of, say, five years. More usable information will thus be accumulated than will be obtained in the next 50 years if we depend upon the voluntary taking of meterorological observations by what few ships navigate this area.

THE RAIN-BEARING WINDS AT ATLANTA, GA.

By CHARLES F. VON HERRMANN

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If almost any one in the eastern part of the United States be asked the question, "From what direction does the wind mostly blow during rain?" the answer will almost invariably be: "From an easterly direction, and when the wind shifts to northwest the weather will soon clear." However, in meteorology as well as in other sciences in order to be sure that a statement of this kind is correct we must have exact measurements. The most recent textbooks on meteorology do not discuss the subject of the rain-bearing winds in any detail, nor do the very complete reports on The Climate of Baltimore, by Fassig, and on the Weather and Climate of Chicago, by Cox and Armington, contain any information on this subject. Therefore it was thought worth while to investigate the matter carefully for a representative eastern station such as Atlanta.

Automatic hourly records of precipitation are available at Atlanta for the 20-year period from 1905 to 1924, inclusive, all taken at the same locality. The record includes the winter season. The occurrence of snow at Atlanta is so rare that on the few occasions when snow has fallen without melting as it fell the hourly amounts were estimated with a fair degree of accuracy and these estimates have been included to make the record complete. Accordingly the amount of rainfall for every hour, including traces, together with the prevailing direction of the wind during each hour and its velocity have been assembled for the entire period and tabulated by months and years.

Summarizing these results in Table 1, the hourly rainfalls and the corresponding prevailing hourly wind directions at the time of the rain, are given in percentages of the total, for eight wind directions, together with the mean velocities for the same directions. The total number of rain-wind hours for the 20 years is 19,311, the total rainfall 968.01 inches, and the mean wind velocity during rain-wind hours 9.7 miles per hour (against a mean velocity for all winds of 11.1 miles per hour), with the elevation of the anemometer always at 216 feet. The wind was calm during rain only three or four times during the period, and in these few instances a wind direction was assumed corresponding to the direction recorded during the preceding hour.

TABLE 1.—*Prevailing winds, amounts of precipitation, and average wind velocities during hours with rain*

Direction	Per cent	Amounts of precipitation (per cent)	Wind velocities (means)
North	3.9	4.9	5.6
Northeast	11.9	12.2	7.8
East	22.4	17.6	10.7
Southeast	20.7	20.3	11.5
South	10.8	12.4	9.0
Southwest	7.6	8.0	9.5
West	10.2	10.8	11.8
Northwest	12.5	13.8	11.7

The necessity for exact measurements is at once shown by the results of the investigation, for the answer given by the layman to the question, "What are the rain-bearing winds?" turns out to be only partially correct. For while the largest amounts of precipitation do occur with east and southeast winds, it happens that northwest winds are next in order and not last. In fact during May, June, possibly July, and August the greatest rainfall occurs with northwesterly winds and not with easterly winds. The exact results have considerable importance in making local weather forecasts for Atlanta and will be given in some detail here.

Results.—The most frequent direction of the wind at Atlanta during rain is east (22.4 per cent), but the largest amount of precipitation occurs with southeast winds (20.3 per cent). Northeast, east, and southeast winds together constitute 55 per cent of the rain-bearing winds, and the amount of precipitation is 50 per cent of the total. Next to the east and southeast, however, the

most frequent direction is northwest (11.5 per cent) and the greatest total rainfall 13.8 per cent.

Apparently the driest winds are from the north, but for certain topographical reasons north winds are infrequent at Atlanta. The really dry wind is the southwest, 7.6 per cent, and total rainfall 8 per cent.

The explanation of these results appears to be quite simple. Most of the rains in winter are of cyclonic origin and chiefly accompany barometric depressions that move from the southwest, or mostly from Texas, toward the northeast either over or north of Georgia; therefore the rainfall occurs chiefly with east to southeast winds. On the other hand a majority of the disturbances that move eastward across the Ohio Valley or Lake region cause much less precipitation in Georgia; the winds then remain east or southeast for only brief periods and the southwest becomes the prevailing wind and is comparatively a dry wind. But why does so much rain fall with northwest winds in summer? Probably because most of it accompanies thunderstorms. During the approach of thunderstorms, nearly always from a westerly direction, the wind may be for a brief period from the east or southeast, but there is generally little rain until the outrushing westerly or northwesterly wind sets in; in fact during many thunderstorms the wind is mostly northwest during the entire time rain continues to fall. It is to be observed also that not only are the rain-bearing winds northwest in summer but they are not even as dry as the north or southwest winds during any season of the year.

The annual average wind velocity at Atlanta, all records considered, at the present elevation of the anemometer is 11.1 miles per hour. The average velocities for only the southeast, west, and northwest rain-bearing winds exceed this, being respectively: Southeast, 11.5 miles per hour; west, 11.8 miles per hour; and northwest, 11.7 miles per hour.

TABLE 2.—*Monthly percentage frequency of rain-bearing winds at Atlanta*

Direction	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
North	2.5	3.2	4.1	2.4	3.5	4.6	3.2	5.2	7.3	5.9	5.3	2.9	3.9
Northeast	9.9	15.9	10.4	9.1	8.0	9.9	7.7	9.2	20.5	19.8	9.7	13.3	11.9
East	29.9	27.3	21.7	17.4	20.8	15.4	12.5	12.9	25.8	24.3	24.5	25.7	22.4
Southeast	17.4	21.0	23.2	21.8	22.9	13.9	24.3	19.1	16 6	20.9	22.0	22.8	20.7
South	7.5	9.4	11.0	13.4	14.6	10.2	14.2	12.7	8.1	8.3	12.1	10.1	10.8
Southwest	5.9	4.7	6.2	10.6	8.2	12.8	12.9	13.2	5.6	3.9	5.4	6.4	7.6
West	12.0	5.7	7.3	12.1	10.4	17.0	14.1	14.2	7.4	6.6	9.7	9.3	10.2
Northwest	14.9	12.8	16.1	13.2	11.6	16.2	11.1	13.5	8.7	10.3	11.3	9.5	12.5

The total amounts of precipitation with each rain-bearing wind do not follow quite the same course, though very nearly so. Table 3 gives the amounts of precipitation with each direction in percentages of the total rainfall.

TABLE 3.—*Monthly percentage of the total rainfall for each wind direction*

Direction	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov	Dec.	Year
North	5.4	5.3	4.7	3.3	3.2	8.4	4.2	4.1	7.5	5.7	4.8	4.3	4.9
Northeast	13.1	18.7	9.6	8.5	7.1	16.6	6.6	9.4	13.8	21.8	12.4	13.0	12.2
East	20.5	20.4	17.1	13.9	16.3	11.9	12.4	12.6	18.6	20.6	17.5	20.2	17.6
Southeast	15.8	23.0	24.0	22.8	17.0	11.4	27.3	13.2	21.4	16.5	25.5	23.9	20.3
South	5.7	11.1	14.6	15.8	16.6	7.5	13.7	16.5	7.2	6.9	15.6	13.7	12.4
Soutwest	4.5	6.5	7.2	9.5	8.8	11.2	10.3	11.1	7.7	6.7	5.3	6.5	8.0
West	9.1	6.8	8.8	12.4	13.4	14.1	13.6	14.5	9.4	9.9	7.1	9.1	10.8
Northwest	16.9	8.2	14.0	13.8	17.6	18.6	11.9	18.6	14.4	11.9	11.8	9.3	13.8

The data given in these tables are represented graphically by Figure 1 for the prevailing directions and Figure 2 for the amounts of precipitation and mean wind velocities.

The differences between the winter and summer months is rather striking, as shown by the diagrams for each month and by Table 4. In January the maximum percentage of precipitation occurs with east winds (29.5 per cent); for the directions northeast, east, and southeast the total amount is 58.4 per cent. In February the largest amounts occur with southeast winds (23 per cent), although the total for the three directions, northeast, east, and southeast, is still the greatest, namely, 62.1 per cent. In March and April the maximum rain-

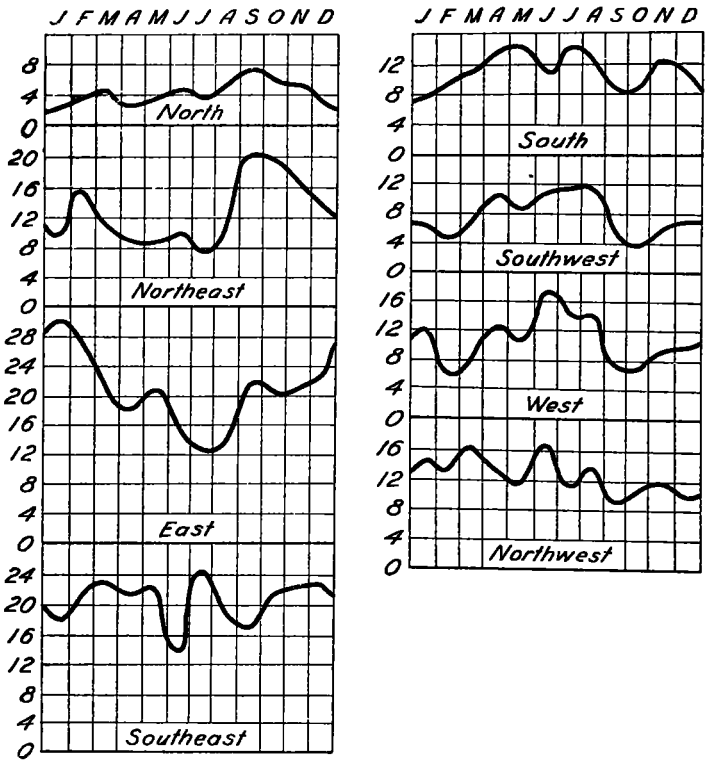

FIG. 1.—Hourly frequency of rain-bearing winds at Atlanta, Ga., for the 20-year period 1905–1924, in percentages of the annual total number of wind directions registered during precipitation

fall has shifted to the southeastern quadrant. In May the largest amounts occur with northwest winds, although the southeast quadrant still retains the maximum total for three directions. But in June the shift to west is complete: Northwest, 18.6 per cent and southwest, west, and northwest, 44.2 per cent. August is identical—northwest, 18.6 per cent, and southwest, west, and northwest, 44.2 per cent. But the intermediate month of July is peculiar, for although the maximum precipitation in July occurs also with northwest winds (17.6 per cent) the southeastern quadrant again shows a maximum for three directions. But this result is entirely due to the fact that during July, 1916, a series of cyclonic depressions (subtropical storms) from the southwest caused unusually heavy rains, with continuous southeast winds for nearly four days (95 hours southeast, with 7.66 inches of rainfall, the number of hours southeast is more than one-third of the total number of times the wind was southeast during the entire 20-

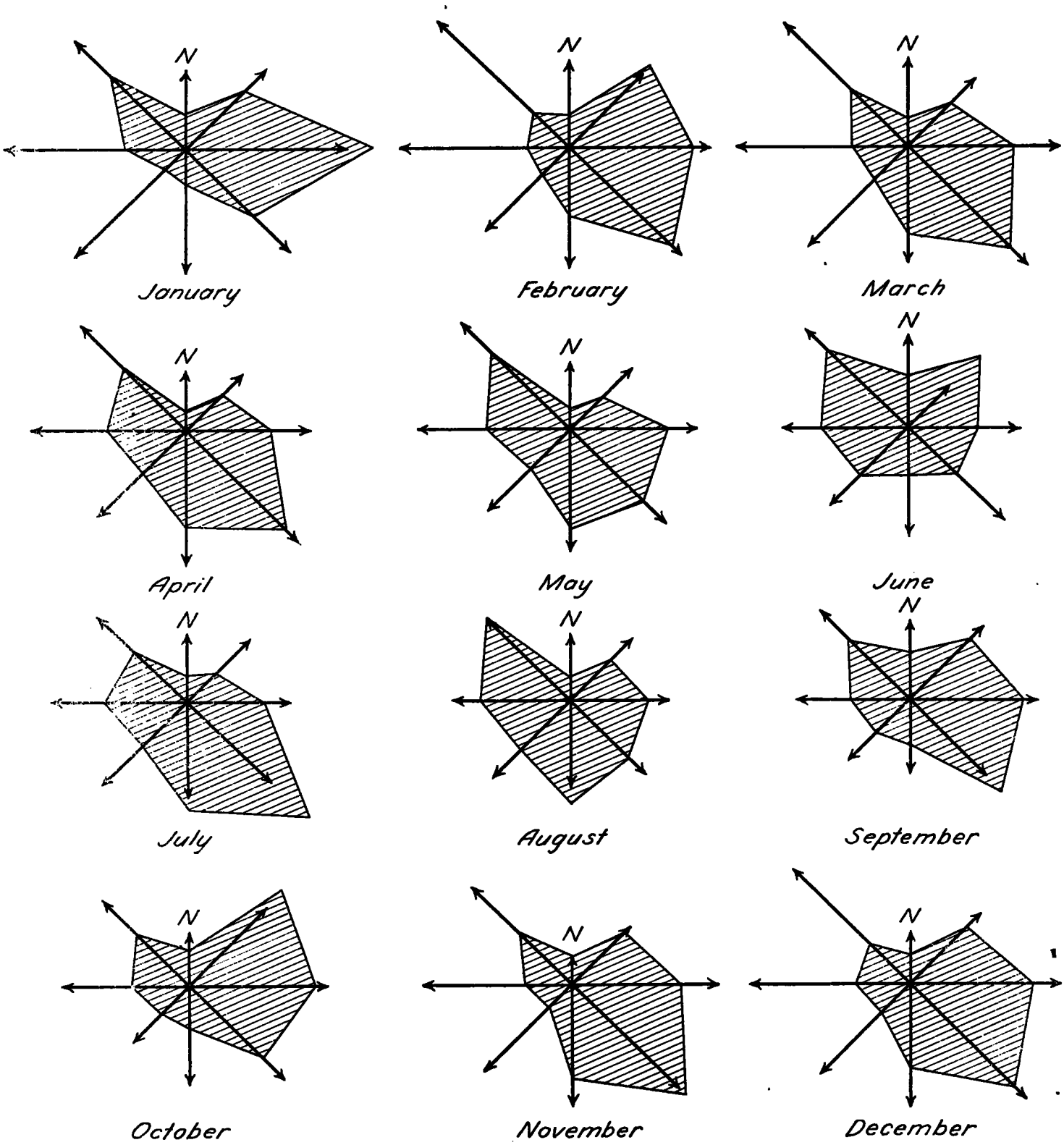

FIG. 2.—Total precipitation, for each direction of the wind, in percentages of the annual total rainfall (read from the origin to the angles of the polygons), and the average velocity of rain-bearing winds, at Atlanta, Ga., for the 20-year period, 1905–1924

year period.) Omitting July, 1916, the record becomes quite similar to that for August.

In September and October there is a backward swing to maximum rainfall during easterly winds, September, northeast, east, southeast, 53.8 per cent, and October northeast, east, southeast, 58.9 per cent, with even the maximum as far around as northeast in October, namely, 21.8 per cent; but during November and December the heaviest rains again occur with southeasterly winds.

The most frequent rain-bearing winds for the year are northeast, east, and southeast, with a total of 62.1 per cent in February, and the driest winds are south, southwest, and west, with 19.3 per cent in January.

It is rather remarkable that the intensity of the rainfall is so nearly the same for each direction of the wind, ranging only from 0.04 inch an hour during east winds to 0.06 per hour during northwest winds, with an average for all other directions of 0.05 inch. Excluding "traces," the hourly intensity (total rainfall divided by the number of hours with 0.01 inch or more) is 0.08 inch.

TABLE 4.—*Wind directions with which occur the average maximum and the average minimum percentage of the total monthly precipitation, 12 months, Atlanta, Ga., together with direction of rain-bearing wind showing average maximum velocity*

	Rainfall and wind directions		Direction showing average maximum wind velocity (m. p. h.)
	Maximum percentage	Minimum percentage	
January	E., 29.5 NE.+E.+SE., 58.4	SW., 4.5 S.+SW.+W., 19.3	W., 14.6.
February	SE., 23.0 NE.+E.+SE., 62.1	N., 5.3 N.+NW.+W., 20.3	NW., 14.7.
March	SE., 24.0 E.+SE.+S., 55.7	N., 4.7 N.+NW.+W., 27.5	NW., 14.2.
April	SE., 22.8 E.+SE.+S., 52.5	N., 3.3 NW.+N.+NE., 25.6	SE., 13.0.
May	NW., 17.6 E.+SE.+S., 49.9	N., 3.2 E.+NE.+N., 26.6	W., 12.3.
June	NW., 18.6 SW.+W.+NW., 44.2	S., 7.5 SE.+S.+SW., 30.1	NW., 11.4.
July	SE., 27.3 E.+SE.+S., 53.4	N., 4.2 NW.+N.+NE., 22.7	W., 10.8.
August	NW., 18.6 SW.+W.+NW.,44.2	N., 4.1 N.+NE.+E., 26.1	NW., 18.6.
September	SE., 21.4 NE.+E.+SE., 53.8	S., 7.2 S.+SW.+W., 24.3	E., 10.7
October	NE., 21.8 NE.+E.+SE., 58.9	N., 5.7 S.+SW.+W., 23.5	SE., 11.1.
November	SE., 25.5 E.+SE.+S., 58.6	N., 4.8 SW.+W.+NW., 24.2	W. and SE., 12.2.
December	SE., 23.9 E.+SE.+S., 57.8	N., 4.3 SW.+W.+NW.,24.9	NW. and SE.,13.2.

Maximum wind velocities during rain.—The record of maximum velocities during rain shows a very pronounced crest for west and northwest winds. Of the total number of maximum velocities exceeding 24 miles an hour during precipitation 52 per cent occurred with west and northwest winds and 30 per cent with east and southeast winds.

During the period of 20 years from 1905 to 1924 maximum wind velocities exceeding 24 miles an hour with and without rain occurred 10,761 times. Computed in percentages of the monthly totals, it appears that 72.6 per cent of the maximum winds occurred without precipitation, and 27.4 per cent during rains. But the distribution by months is rather peculiar and bears out the explanation why the maximum rainfall occurs during summer with northwest winds. During the period from September to May, inclusive, the percentage of maximum winds occurring without precipitation is 83.2 per cent and with precipitation, 16.8 per cent, while during the three summer months the percentage of maximum winds without rains is only 41, and with rains 59. The fact may also be noted that considering the extremes of wind movement or the highest velocities for each month of the year at Atlanta (1879–1924) only four, those for January, July, August, and December, were dry winds; during the remaining months of the year the highest velocities all occurred while rain was falling, including the maximum velocity registered, namely, 66 miles northwest, March 24, 1909.

Duration in hours of rain-bearing winds.—A study of the duration in consecutive hours of rain-bearing winds at Atlanta shows that during precipitation the winds are extremely variable. On the average during the year the wind blows from the east for only three consecutive hours and from all other directions for only two consecutive hours. The maximum average for single months is only 4 hours with east winds during January, February, and November. A summary of the total consecutive hourly periods shows that 88 per cent of the rain-bearing winds last for only 1, 2, or 3 consecutive hours, and only 1 per cent for over 12 hours. There are, of course, a few extreme records, as for example: east winds, February, 1908, 42 consecutive hours with, however, only 1.22 inches of precipitation; east winds, March, 1909, for 25 hours with 2.20 inches of precipitation, and southeast winds in July, 1916, for 38 hours with 4.27 inches of precipitation; but these are the only cases on record in 20 years when the rain-bearing winds lasted for more than 24 hours from the same direction.

NOTES, ABSTRACTS, AND REVIEWS

PRECIPITATION IN THE FORM OF ICE SPICULES AT TEMPERATURES NEAR FREEZING

By FRED H. WECK

(Springfield, Illinois)

On Saturday, November 7, 1925, there occurred at Springfield a light fall of snow that was somewhat out of the ordinary.

It had been raining all day and the pressure started to rise at 4:00 p. m., with the wind changing from northeast to northwest. At 6.25 p. m., with a temperature of 34°, small irregular-shaped particles of ice began falling with the rain. It was sleet. About 7:45 p. m., the temperature being 29°, the sleet was mixed with ice needles. They were examined at intervals until about 8:30 p. m., when all the precipitation falling was in the form of the spiculæ, the temperature having fallen to 27°. They were observed under a glass and were found to be of different lengths, some of them nearly one-sixteenth inch long, but most of them approximately one thirty-second inch or less. They were neither clear nor perfectly white, but when piled up looked at a distance of a few feet like ordinary snow. Each needle had very minute feathery projections on the sides. Care was taken to find some hexagon-shaped flakes but none were discovered. * * *

The above observation was submitted to Mr. Wilson A. Bentley, of Jericho, Vt., who commented as follows:

I have observed and photographed the ice spiculæ form of snow crystal, many times here in Jericho, although they are relatively rare. They usually fall during mild temperature and always, so so far as I have observed, from low-lying clouds. They seem very similar to the needle form of cloud frost that forms apparently from cloud droplets, and attach themselves to tree twigs, etc., on mountain tops. My belief is that this form of snow crystal is subcrystalline in nature, and due to the joining of many fluid cloud droplets one to another to form a rod-shaped ice spicula.